ELECTROGRAPHICAL ANALYSIS OF ORE TEXTURES

By Gy. GRASSELLY

A) Chemical qualitative examination:

The detection of cobalt

In the course of the examinations carried out last year α-nitroso-β-naphtol proved to be the most suitable reagent for the electrographical detection of cobalt minerals. It showed a reddish-brown colourization with cobalt. Copper and ferric iron interfere with the demonstration.

In order to avoid the interference of these two ions either another reagent should be employed, or the copper and iron masked. For qualitative and quantitative analysis of cobalt potassium nitrite is a commonly used reagent. However, in the course of the electrographical examinations purposing the detection of cobalt this reagent furnished far less good results than those obtained with α-nitroso-β-napthol. Although the gelatine paper treated with potassium nitrite showed the yellow colour characteristic for cobalt, yet on the sites of the polished sections containing iron a similar colour coud also be detected, whilst on those correspoding to the granules containing copper a greenish colourization appeared. Moreover the colourization obtained with potassium nitrite was weaker and more blurred than that prduced by the other reagent.

Hence the circumstances interfering with the detection of cobalt with α-nitroso-β-napthol should be eliminated. When distinctly cobalt minerals are involved and cobalt dominates and the interfering iron and copper are at the most present in small amounts, the demonstration of cobalt is unequivocal.

However, in non-cobalt minerals — which may, however, contain cobalt impurities — it is also often essential to detect the presence or absence of cobalt. Thus for instance in the mineral association of Nagybörzsöny cobalt can be found in association with arsenopyrite. However, if it is also possible to establish the presence of cobalt by means of routine chemical qualitative analysis, the essential question with which arsenopyrite generation the cobalt is associated, with the older or with the younger remains unelucidated. This question cannot be decided by chemical or microscopical examinations. In such cases the electrographical procedure is most useful, as the reprint reflects the distribution of the ore granules truly thus rendering possible the unambiguous settling of the question. On the basis of these examinations cobalt belongs to the younger arsenopyrite generations. In order to demonstrate the cobalt contained in the arsenopyrites the iron had in the first place

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to be masked to eliminate its interference. The more so since in the case of other minerals containing iron, ferric iron interfered only to a small extent with the demonstration, whereas in the case of arsenopyrite and löllingite the reprint obtained on the paper impregnated with α-nitroso-β-naphtol showed such a dark brown colour that this might truly mask the colourization produced by the slight amount of cobalt.

The elimination of the interference of the iron is accomplished as follows: iron and cobalt form with sodium phosphate iron phosphate and cobalt phosphate respectively. Of these phosphates only cobalt phosphate reacts with the reagent, iron phosphate does not give a reaction, the faint yellow colour of the latter can hardly be detected on the gelatine paper which the action of the reagent has already turned yellow. The gelatine paper is first treated with a solution of sodium phosphate then electrolysed and subsequently immersed for a short time in the reagent solution. The examination can also be performed by immediately impregnating with the reagent, the gelatine paper treated with sodium phosphate, hereupon the excess moisture is eliminated and the electrolysis carried out. The result is satisfactory the cobalt can be readily detected without that the iron causes any interference.

Copper is the second interfering ion. It produces a brown colourization resembling that of cobalt, thus if the arsenopyrite contains scattered chalcopyrite granules these can easily be confounded with the colourization due to the cobalt impurities. The elimination of the interference is accomplished as follows: the paper is treated with a solution of potassium iodide, and then electrolysed. Cuprous iodide forms and, owing to the evolved iodide, the colour of the paper turns brown. In order to eliminate it the gelatine paper is immersed in a sodium thiosulphate, or a weakly acidified sodium sulphite solution, the excess moisture removed and the test paper introduced into a solution of the reagent.

The interfering effects exerted by iron and copper can also be eliminated simultaneously by immediately trating the gelatine paper with a solution of potassium iodide and sodium phosphate the further procedure is similar to that applied for the elimination of the interference of copper. If the polished section contained any cobalt — also only a slight amount — its characteristic colourization will appear without interference.

The detection of iron-arsenic minerals

α-nitroso-β-naphtol is not only suitable for the detection of cobalt but for that of iron-arsenic minerals (arsenopyrite, löllingite etc.) in general. Inasmuch as if an ore texture also contains these minerals granules the gelatine paper treated with the reagent shows a dark brown colourization on the sites corresponding to the granules. Hence, löllingite as well as arsenopyrite can readily be differenciated from the cobalt- and nickel arsenides with which they are easily confounded under the ore microscope. This way of detection is the more advantageous since, on the one hand it takes far less time than the individual demonstration of iron and arsenic, and on the other hand, the brown colourization appearing on the test paper treated with α-nitroso-β-naphtol could so far be detected only on the action of iron-arsenic minerals and not in the case of other minerals (smaltite, chloantite, safflorite, ullmanite, linneite, nickelite), hence the reaction is characteristic for iron-arsenic minerals.

The detection of arsenic

Gelatine paper treated with silver nitrate is suitable for the demonstration of arsenic. Between the reagent paper and the cathode some layers of filter paper — impregnated with a solution of electrolyte — should be placed, as otherwise the silver which is extremely quicly reduced spoils the reprint. The detection of arsenic was attempted on section of löllingite, arsenopyrite, tetrahedrite, enargite and native arsenics. In contrast to the others, this reprint cannot be preserved.

The detection of lead and bismuth

In the case of the detection of lead the fact of the surface of the ore used as anode becoming oxidized in the course of the electrolysis a lead oxide layer forming upon it caused difficulties. The potassium chromatous procedure suggested earlier did not either furnish adequate results. The benzidinous reaction which is usually a suitable procedure was also not applicable for electrographical examinations. The colourization produced on paper merely treated with potassium iodide was not either satisfactory However, the reaction with cinchonine + potassium iodide attempted on galena and jamesonite proved to be reliable. In the course of the reaction a thin iridescent membrane formed on the surface, due to the iodide evolved, which could be easily removed with a cloth moistened with a solution of thiosulphate.

The reagent used for the treatment of the gelatine paper: 0,1 g of cinchonin dissolved in water (10 ml) and slightly acidified with nitric acid is dissolved under heating, on dissolution and cooling potassium iodide 0,2 g is added. In the presence of lead a yellow colourization appears. Really speaking the reagent ought not to be suitable for the detection of lead associated with bismuth, as bismuth produces an orange yellow colour with the reagent, however, in the case of sulphide ores the various bismuth minerals (bismuthinite, cosalite, tetradymite and other bismuth tellurides) do not interfere as they are not conductive. By means of the cinchoninous-potassium iodidous reaction metallic bismuth can be detected in different alloys.

The detection of zinc

Potassium ferrocyanide was generally used for the detection of zinc. Considering that potassium ferrocyanide is not a specific zinc reagent a reagent had to be found with which the latter could be unequivocally detected. On the basis of qualitative as well as quantitative analyses it is known that zinc forms with mercury rhodanide a white zinc mercury rhodanide. Quantitative determination cannot be carried out in the presence of copper, as copper forms a similar compound with the reagent. However, this characteristic is applicable for qualitative examinations. The gelatine paper is permeated with ammonium sulphate and electrolysed and subsequently placed after removing the excess moisture into the reagent solution. A small piece of gelatine paper is first impregnated with amonnium sulphate and then with copper sulphate and also introduced into the reagent sulution. The gelatine paper used as blank turns greenish, whereas in the presence of zinc the test paper shows a greyish lilac colour corresponding to the sites containing this ore. The colourization develops slowly.

The following procedure is similarly well applicable: the colour of the dilute cobalt nitrate solution (0,02 per cent cobalt solutin) on mixing with

ammonium mercury rhodanide turns extremely slowly blue. As contrasted with this in the presence of only a very slight amount of zinc a very strong blue colourization is instantaneously produced. The gelatine paper is impregnated with a solution of ammonium sulphate and subsequently on removing the excess moisture electrolysed the paper having previously been immersed into dilute cobalt nitrate or sulphate solution and then the excess moisture again removed the paper is introduced into the reagent solution. The paper shows almost instantaneously on the places corresponding to the granules containing zinc a blue colourization, whereas the blank merely impregnated with ammonium sulphate and cobalt solution remains colourless for a fairly long period turning then slightly blue.

The detection of silver

Attempts to use one or the most sensitive silver reagents paradimethylamidobenzylidenrhodanine for the detection of silver by the means of electrographical investigations failed. When an acetonic solution of the reagent was used to impregnate the test paper the reprint was either blurred or the test-paper dried and did not conduct. Hence the impregnation of the paper with sodium- or potassium bromide and its treatment after electrolysis with a photographic developer proved to be the most satisfactory method.

B) Structure etching

Structure etching is in addition to local qualitative chemical analyses another field for the application of electrographical examinations. This procedure is well known and has been much applied for both metallographic and ore textur examinations. Essentially the procedure is as follows: either the examined sample is immersed with its ground polished side into a suitable electrolyte solution and used as anode, as cathode a platinum plate is applied, or the whole procedure is carried out in a platinum dish applied as cathode and the electrolysis accomplished.

If the structure etching is performed with an apparatus also used for electrographical chemical investigations the procedure is far simpler. A filter paper layer impregnated with ammonium sulphate (10 perc cent) or ammonium chloride solution is placed onto the aluminum plate used as cathode and the polished section to be examined is put onto this paper layer with its grounds side downwards and the electrolysis iniciated.

Structure etching produced by electrolysis is particularly suitable in cases in which the ore involved is considerably resistant to the generally used corrosives. Although it is clear that electrolytic etching does not either develop other structures than those produced by other etching means — provided that the investigated ore is not resistant to corrosives — yet the following considerations support its application:

a) the procedure is simpler and more conveniant than the usual ones, moreover a relatively even etching is produced on the entire surface of the polished section.

b) the use of various acids and bases and other chemicals applied as corrosives is eliminated. At the structure etchings illustrated on the microphotos ammonium sulphate (10 per cent) could be used in all cases as electrolyte. Whereas, at the etchings done in the usual manner the following corrosives would have been maded: for arsenopyrite alkaline hydrogen hyperoxide and

alkaline potassium permanganate solutions respectively, for bornite an iodideous potassium iodide solution, for galena alcoholic nitric acid, for chalcopyrite alkaline potassium permanganate, or concentrated hydrochloric acid or a mixture of concentrated nitric acid and potassium perchlorate; for chalcocite that of concentrated nitric acid or potassium cyanide, for lusonite — famatinite a solution of potassium cyanide, and finally for nickelite one of sulphuric acid with hydrogen hyperoxide or potassium permanganate,

c) its greatest advantage lies in the fact that the extent of the etching can be controlled as desired by regulating the action period and the intensity of current, respectively. In the intervals the progress of the etching can be controlled under the microscope. Both granule-boundary and surface etching can be brought about. The electrolysis is begun at low current rate after a short time the effect is controlled under the microscope, and subsequently — gradually increasing the current intensity — the electrolysis can be continued to the desired extent. Thus the smallest and finest details cannot avoid our attention which later in the course of the etching might disappear.

The structure etching of chalcocite
(phot. 1—4.)

The electrolysis was carried out for one minute with 1 mA, then for one minute with 2 mA, subsequently for two minutes with 3 mA and finally for another one minute with 4 mA. In the initial stage only the granule boundaries can be detected (phot. 1.), presently they become more pronounced (phot. 2.) finally a perfect granular surface etching is produced (phot. 3.). Phot. 4. shows also a structure etching of a chalcocite.

The structure etching of lusonite-famatinite
(phot. 5—7.)

In a short time the procedure developed a fine polysynthetic twin lamellar structure on which the translation was also well visible.

The structure etching of bornite
(phot. 8.)

On bornite structure etching is usually considerably difficult to develop. Electrolytically a prolonged action produced a granular boundary etching.

The structure etching of nickelite
(phot. 9—10.)

The structure etching was developed with 2—3 mA and 0,6—0,7 V. The translation twin lamellar structure can be very well detected.

Structure etching of chalcopyrite
(phot. 11—14.)

In the case of chalcopyrite the twin lamellae was developed with 1 mA (phot. 11.) the granule boundary and the twinning on the granular surface

(phot. 12.) with 2 mA (3V) for three minutes, whereas the granule-boundary and twinning illustrated on phot. 13. was produced by electrolysis for five minutes with 0,2 mA, for five minutes with 0,4 mA, for five minutes with 0,6 mA, for one minute with 2,5 mA and finally for one minute with 5 mA. After the etchings the irised film formed on the surface of chalcopyrites, but also in the case of the other minerals can be removed with a short and light polishing on cloth with magnesia.

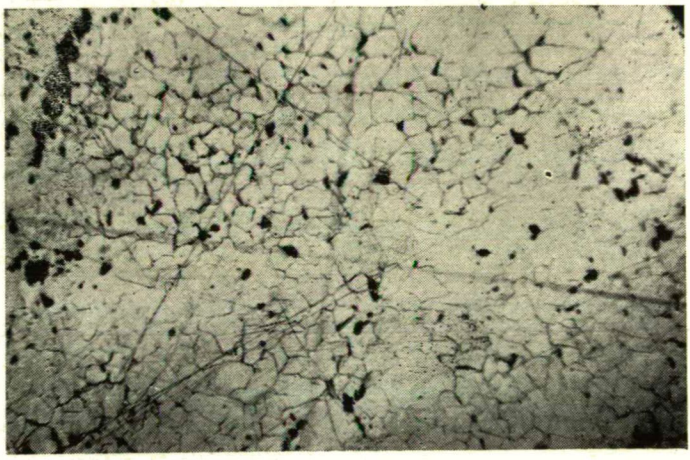
Structure etching of galena
(phot. 15—16.)

On the surface of galena sometimes irregularly and sometimes regularly arranged unaffected polished surfaces remain (phot. 15.), in the latter case they form a distinct angle with the cleavage direction of galena (phot. 16.).

Structure etching of arsenopyrite
(phot. 17.)

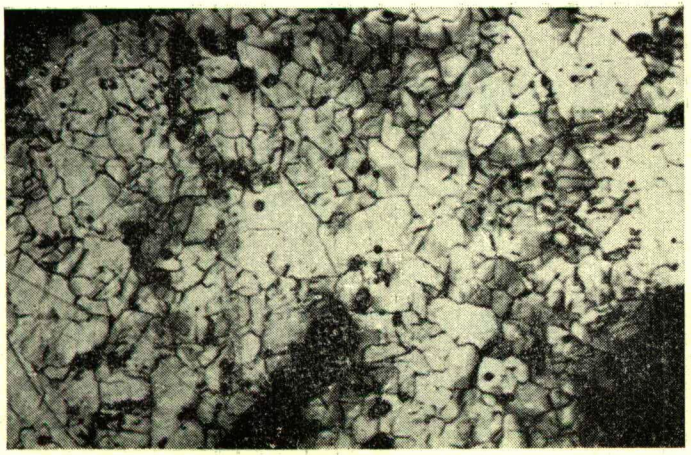
In the case of arsenopyrite with 2—4 mA a good structure etching can also be developed the granule-boundary and growths zones (twinning lamellar structure) are equally well visible.

Of course electrolytic structure etching can only be applied with conductive ores as electrographical methodes can also only be applied for qualitative chemical investigations in the case of conductive ores. This represents a certain inhibition, however, only with respect to the point of view of the latter examinations, whereas in the case of structure etching the fact that some granules become etched in the polished section, whilst others, e. g. bismuth minerals, bismuth tellurides and sphalerite remain intact and polished, may even be regarded as charasteristic.

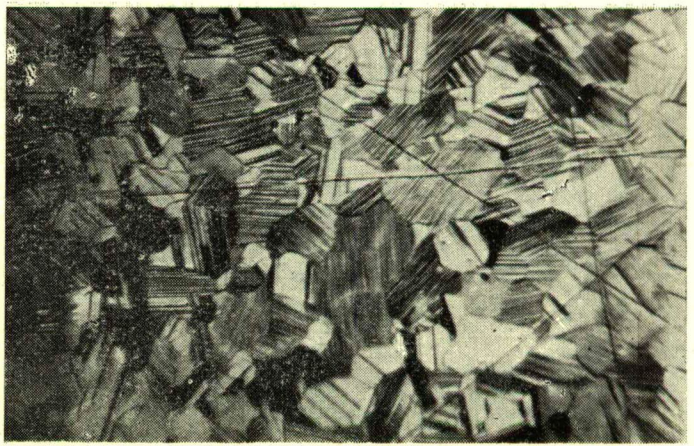


1.

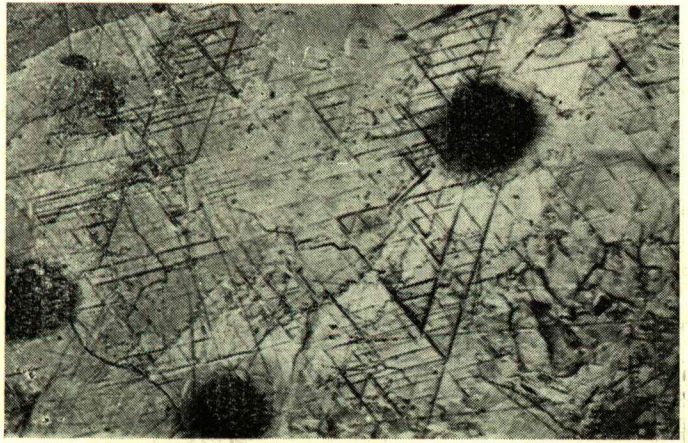
Chalcocite, 70 ×



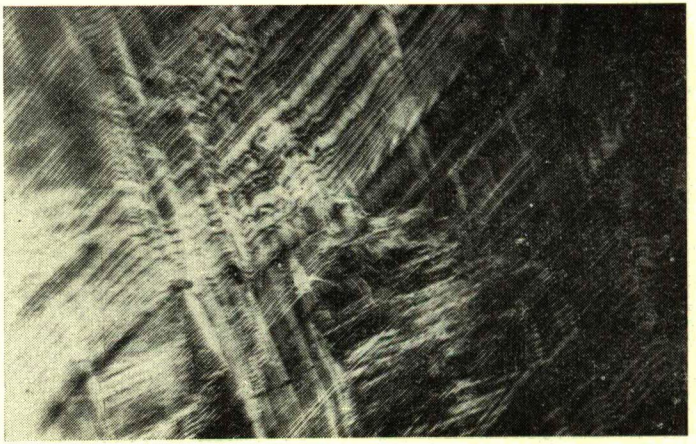
2. Chalcocite, 90 ×



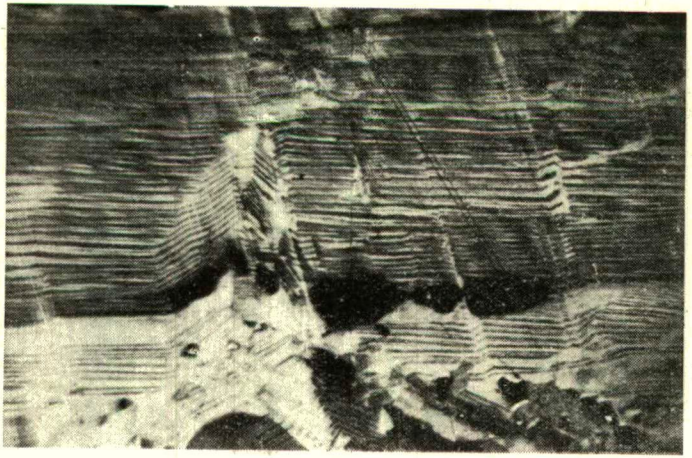
3. Chalcocite, Oel imm. 400 ×



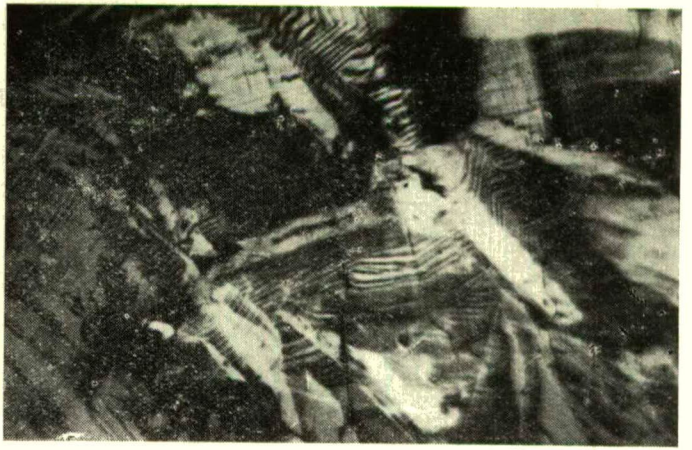
4. Chalcocite, 90 ×



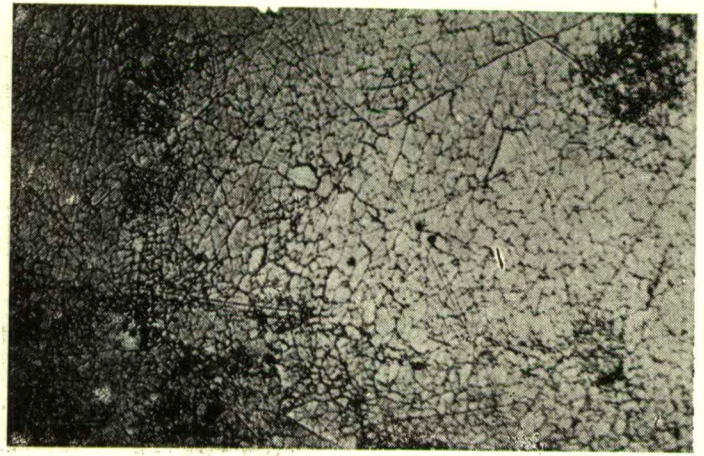
5. Luzonite-famatinite, Oel imm. 400 ×



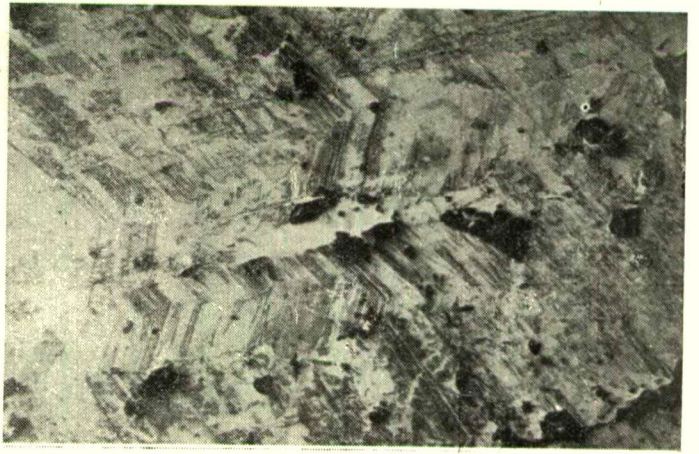
6. Luzonite-famatinite, Oel imm. 400 ×



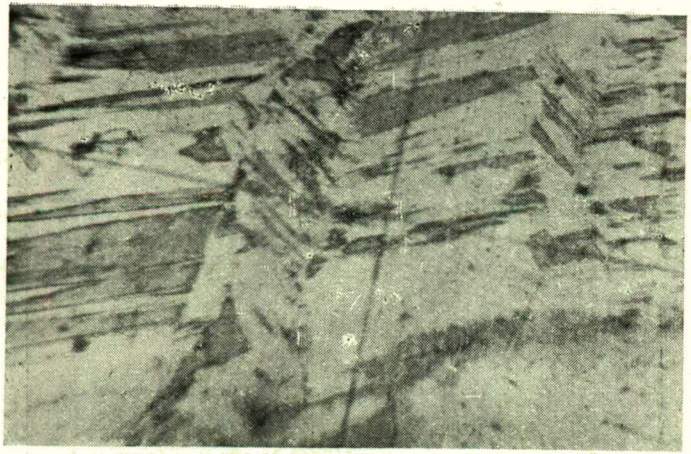
7. Luzonite-famatinite, Oel imm. 400 ×



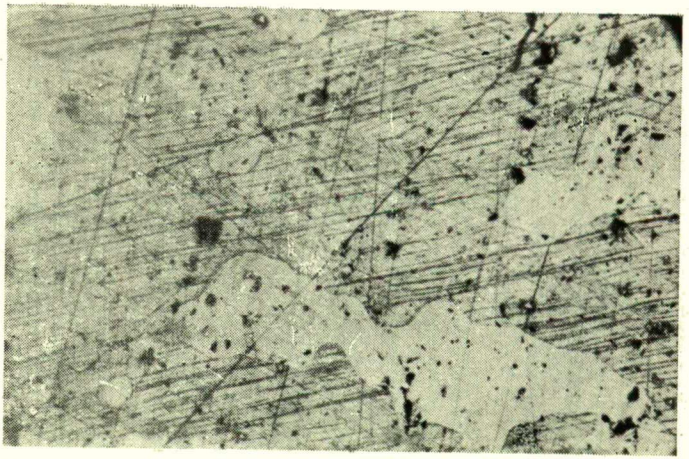
8. Bornite, Oel imm. 400 ×



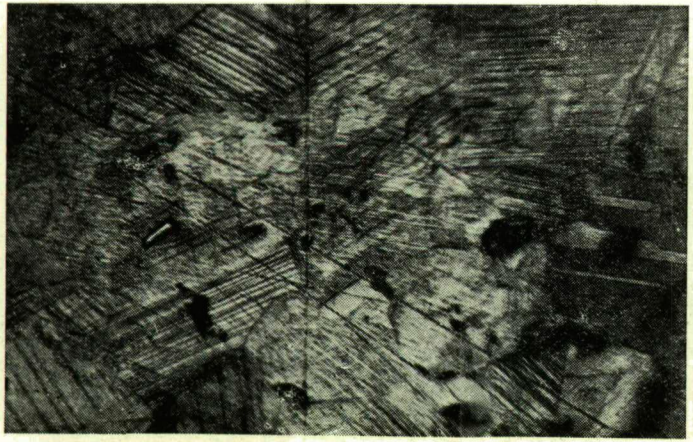
9. Nickelite, 70 ×



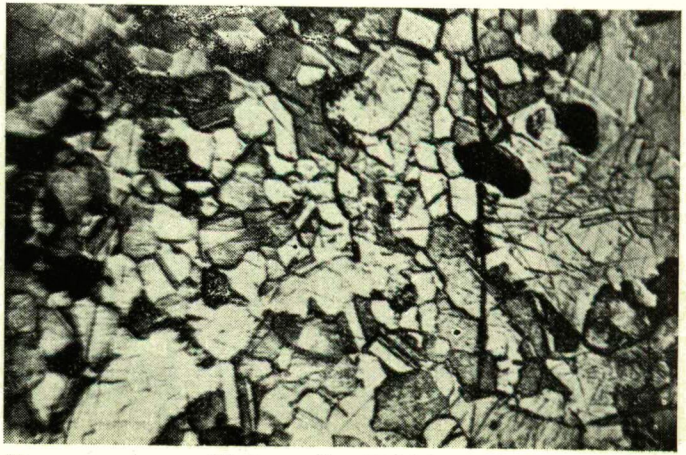
10. Nickelite, 300 ×



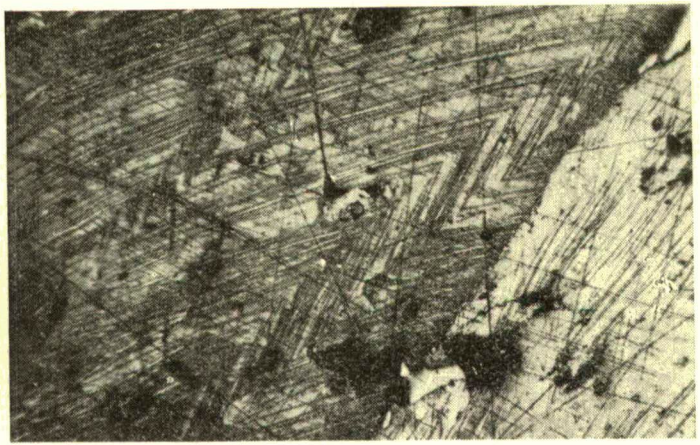
11. Chalcopyrite, 70 ×



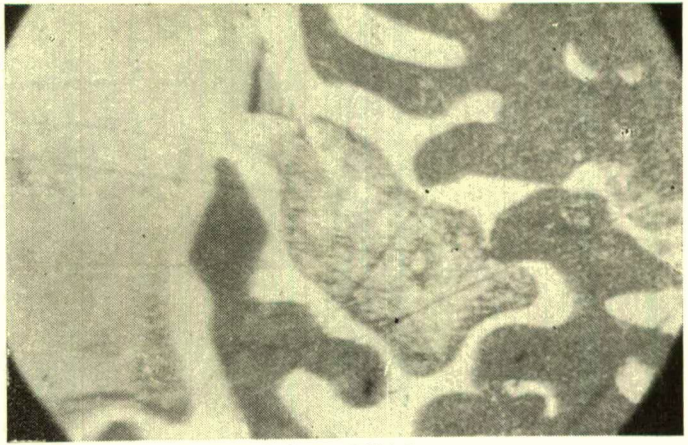
12. Chalcopyrite, Oel imm. 400 ×



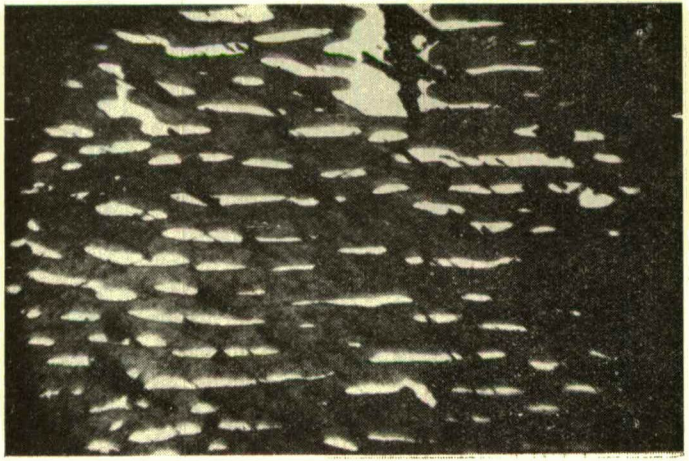
13. Chalcopyrite, 70 ×



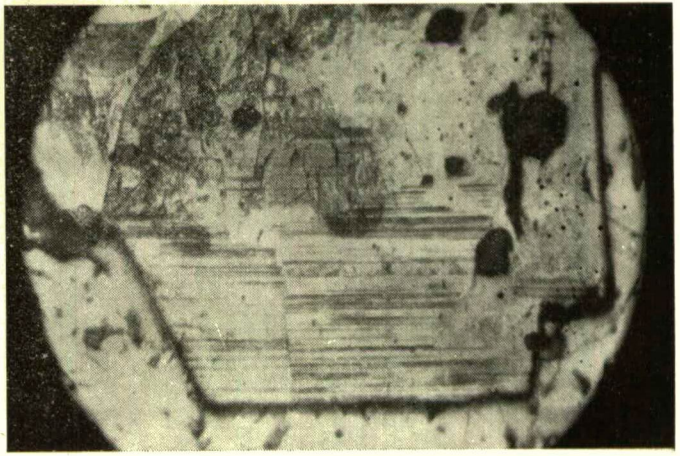
14. Chalcopyrite, 260 ×



15. Galena, 260 ×



16. Galena, 90 ×



17. Arsenopyrite, 100 ×

ЭЛЕКТРОГРАФИЧЕСКИЙ АНАЛИЗ РУДНОЙ ТКАНИ.

— ЮЛИЙ ГРАССЕЛЛИ —

Обнаружению кобальта с α-нитрозо β-нафтолом мешают железо и медь. Мешающее действие можно устранить, если желатинную бумагу обрабатывать фосфатом натрия, затем иодидом калия, тогда, тиосульфата натрия, потом в реактивный раствор уксусной кислоты. Этим путём мешающее действие меди и железа было совершенно устранено и напр. в арсенопиритах и в лёллингитах можно обнаружить и ничтожные количества кобальта. Вышеупомянутый реагент одновременно пригодится и к обнаружению сернистых мышьяков железа в рудных тканях, поскольку он на желатинной бумаге, пропитанной реагентом, вызывает сейчас же чёрнобурый цвет, отклоняющийся от окраски, вызванной кобальтом. Мышьяк обнаруживается на желатинной бумаге, обработанной нитратом серебра. Для обнаружения свинца и висмута служит реагентная бумага, обработанная раствором иодида калия и цинхонина. Чтобы обнаруживать цинк, реагентная бумага обрабатывается разбавленном раствором нитрата кобальта, потом проводится электролиз и погружение её в раствор роданата аммония. На месте рудных зерн, содержащих цинк, появляется интенсивная синяя окраска.

Другая область применения электрографии — травление структуры. Идущее таким путём травление структуры обладает тем главным преимуществом, что мера воздействия зависит от нашего усмотрения, легко регулируется и, в это время, подвигание травления под микронкопом контролируется. Проведенные этим способом травления структур изображанные на фотоснимках, совершались за несколько минут, при нескольких mA

Table 4.

Tápé	Ca	Mg	Na	K	Fe	Cl	SO_4	HCO_3	CO_3	PO_4	Cations	Anions
I. 28.	2,0570	0,6474	0,8665	0,0999	0,0029	0,4197	0,7140	2,6200	—	0,0094	3,6737	3,7631
II. 25.	1,3550	0,6148	0,5235	0,0852	0,0114	0,2676	0,5510	2,0140	—	0,0103	2,5899	2,8429
III. 3.	1,5910	0,8981	0,6757	0,1069	—	0,4056	0,6386	2,2945	—	0,0120	3,2717	3,3507
III. 10.	1,8840	0,7939	0,8500	0,1018	—	0,7661	0,7389	2,3150	—	—	3,6297	3,8200
III. 17.	2,3750	1,0295	0,7830	0,1385	—	0,7465	0,8555	2,8760	—	—	4,3260	4,4780
III. 24.	2,0070	1,3440	0,4193	0,0644	0,0028	0,6535	0,7391	2,4580	—	—	3,8375	3,8506
III. 31.	1,4740	0,8284	0,5686	0,1249	—	0,4056	0,4107	2,1840	—	0,0120	2,9959	3,0123
V. 12.	1,7425	0,4989	0,5748	0,0534	0,0025	0,3098	0,4825	2,1790	—	—	2,8721	2,9713
V. 19.	1,9540	0,5695	0,5548	0,0693	0,0111	0,4816	0,5713	2,1900	—	—	3,1587	3,2429
V. 26.	1,8790	0,6025	0,6448	0,1017	0,0122	0,5154	0,5849	2,2150	—	0,0102	3,2402	3,3255
VI. 2.	2,1395	0,8481	0,6604	0,0736	0,0078	0,5437	0,6638	2,4130	—	—	3,7294	3,6205
VI. 9.	1,8043	0,9335	0,9013	0,1018	0,0021	0,6535	0,6399	2,4496	—	—	3,7430	3,7430
VI. 16.	1,5350	0,5493	1,0535	0,1046	0,0011	1,3197	0,4927	1,6597	—	—	3,2435	3,4721
VI. 23.	1,6975	0,6790	0,6309	0,0859	0,0093	0,6451	0,5133	2,0297	0,0600	—	3,1026	3,2481
VI. 30.	1,9700	0,7488	0,5048	0,0816	0,0025	0,4887	0,4448	2,0997	0,1600	—	3,3077	3,1932
VII. 7.	1,4900	0,9433	0,7435	0,0903	0,0025	0,5183	0,5612	2,2396	0,1200	—	3,2696	3,4391
VII. 14.	1,3870	0,8235	1,3143	0,1026	0,0014	1,4254	0,5440	1,6797	0,0600	—	3,6288	3,7091
VII. 21.	2,3645	1,0213	1,0022	0,1770	0,0057	0,7323	0,6570	2,9495	0,2600	—	4,5707	4,5988
VII. 28.	2,8050	1,0874	0,9547	0,0989	0,0028	0,3051	0,8657	3,2594	0,3727	—	4,9488	4,8029
VIII. 4.	2,6300	0,7688	1,3183	0,0788	0,0032	0,4456	0,7392	3,3694	0,1647	—	4,7991	4,7189
VIII. 11.	2,5975	0,6190	1,1526	0,0859	0,0021	0,2992	0,7975	3,1694	0,2100	—	4,4571	4,4761
VIII. 18.	2,4850	0,6338	1,0661	0,1199	0,0011	0,3946	0,7700	2,9243	0,1826	—	4,3059	4,2715
VIII. 25.	2,6150	0,8268	1,0339	0,0934	0,0028	0,2659	0,8349	3,3194	0,1737	—	4,5719	4,5936
IX. 1.	2,7800	0,6232	1,0486	0,1026	0,0007	0,2704	0,7660	3,3195	0,0183	0,0009	4,5551	4,3751
IX. 8.	2,7750	0,5443	1,1891	0,0962	0,0007	0,3543	0,7535	3,2994	0,0183	0,0009	4,6053	4,4264
IX. 15.	2,5725	0,5443	1,0691	0,1141	0,0007	0,3042	0,7327	3,0400	0,0373	0,0034	4,3007	4,1176
IX. 22.	1,9170	0,7635	1,0391	0,0274	0,0029	0,2592	0,7577	2,6756	0,0737	0,0043	3,7499	3,7705
IX. 29.	2,5600	0,3415	0,9574	0,0982	0,0057	0,3183	0,7577	2,8895	—	0,0009	3,9628	3,9664
X. 6.	2,2420	0,3415	0,3900	0,0693	0,0075	0,0592	0,4080	2,4696	—	0,0009	3,0503	2,9377
X. 13.	1,5535	0,3465	0,4526	0,0783	0,0111	0,0732	0,4996	1,8997	—	0,0009	2,4420	2,4734
X. 20.	1,8695	0,6387	0,5078	0,0785	0,0043	0,3972	0,4670	2,2796	—	0,0013	3,0991	3,1451
X. 27.	1,6145	0,5839	0,3883	0,0816	0,0061	0,2914	0,4706	1,9107	—	0,0009	2,6744	2,6736
XI. 3.	1,5250	0,5239	0,3122	0,0368	0,0114	0,1775	0,3684	1,8197	—	0,0009	2,4090	2,3965
XI. 11.	1,4070	0,5139	0,2717	0,0665	0,0093	0,2366	0,2227	1,8097	—	0,0011	2,2684	2,2701
XI. 17.	1,4560	0,5837	0,4669	0,0297	0,0075	0,3042	0,4017	1,8397	—	0,0012	2,5438	2,5468
XI. 26.	1,3350	0,5941	0,4004	0,0448	0,0100	0,1775	0,3455	1,8187	—	0,0017	2,3843	2,3438
XII. 1.	—	0,2607	0,3147	0,0598	0,0064	0,1634	0,4484	1,7406	—	0,0009	—	—
XII. 8.	1,3560	0,5435	0,3583	0,0586	0,0114	0,1887	0,3936	1,7197	—	0,0011	2,3278	2,3031
XII. 16.	1,6090	0,3997	0,4761	0,0304	0,0025	0,2451	0,4858	1,8597	—	0,0007	2,5177	2,5913
XII. 22.	1,6410	0,4745	0,4086	0,0550	0,0204	0,2169	0,4278	1,8898	—	0,0009	2,5995	2,5354
XII. 30.	1,4035	0,6741	0,3352	0,0683	0,0016	0,1977	0,4448	1,7597	—	0,0009	2,4827	2,4031

Table 5.

Szeged	Ca	Mg	Na	K	Fe	Cl	SO_4	HCO_3	CO_3	PO_4	Cations	Anions
I. 30.	2,2965	0,7648	0,8700	0,0936	0,0018	0,9577	0,7119	2,5099	—	0,0052	4,0327	4,1847
II. 28.	1,8070	0,6924	0,6778	0,0881	0,0029	0,5493	0,7107	2,0599	—	0,0043	3,2682	3,3242
III. 5.	1,8465	0,7266	0,8361	0,0794	—	0,7268	0,6953	2,1299	—	—	3,4886	3,5520
III. 12.	2,2450	0,7889	0,9520	0,1104	—	0,9887	0,7346	2,6100	—	—	4,0963	4,3333
III. 19.	2,2450	0,8686	1,0748	0,1862	—	1,0816	0,6146	2,6698	—	0,0155	4,3746	4,3815
III. 26.	2,2450	0,7143	1,0287	0,0975	0,0079	1,0845	0,6394	2,3600	—	0,0044	4,0934	4,0883
IV. 2.	2,1155	0,6696	0,6939	0,0996	0,0050	0,5493	0,7910	2,1700	—	—	3,5836	3,5103
IV. 6.	1,7670	0,5750	0,4504	0,0721	0,0223	0,3211	0,4788	1,8400	—	—	2,8868	2,6399
IV. 12.	1,5220	0,5679	—	—	0,0105	0,3239	—	1,6400	—	—	—	—
IV. 21.	1,6035	0,5860	0,4256	0,0794	0,0093	0,3521	0,4639	1,6300	—	0,0103	2,7038	2,4563
IV. 28.	1,5790	0,5467	0,5765	0,0512	0,0039	0,5154	0,3455	1,6400	—	0,0017	2,7573	2,5026
V. 5.	1,5085	0,4729	0,4791	0,0503	0,0329	0,6085	0,4208	1,6400	—	—	2,5437	2,6693
V. 14.	1,7180	0,4835	0,7091	0,0880	0,0051	0,4901	0,6457	1,8200	—	—	3,0037	2,9558
V. 21.	1,8815	0,5205	0,3619	0,0462	0,0045	0,3324	0,7138	1,8400	—	—	2,8147	2,8862
V. 28.	1,9545	0,6579	0,4909	0,0469	0,0050	0,5465	0,5530	2,0499	—	—	3,1552	3,1494
VI. 4.	2,0740	0,7044	0,6539	0,0935	0,0057	0,6873	0,6598	2,3399	—	—	3,5315	3,6870
VI. 11.	1,7875	0,7438	0,9252	0,0685	0,0014	0,8592	0,5579	1,9897	—	—	3,5264	3,4068
VI. 18.	1,9995	0,8235	0,9200	0,0780	0,0025	0,8380	0,6869	2,2296	—	—	3,8235	3,7545
VI. 25.	1,8700	0,3842	0,7387	0,0483	0,0054	0,5901	0,5133	1,9696	0,0600	0,0600	3,0466	3,1330
VII. 2.	1,6450	0,7183	0,9013	0,1033	0,0039	0,8310	0,4586	2,0797	—	—	3,3718	3,3693
VII. 9.	1,9520	0,9293	0,8173	0,0969	0,0057	0,7127	0,6374	2,2696	0,1200	—	3,8012	3,7397
VII. 16.	2,2750	0,9211	1,0839	0,1718	0,0078	1,1098	0,6911	2,6295	0,0200	—	4,4596	4,4504
VII. 23.	2,3300	0,9795	1,1222	0,1179	0,0132	1,3296	0,6370	2,4262	0,0600	—	4,5628	4,4528
VII. 30.	2,6725	0,9286	1,2235	0,0839	0,0014	0,7775	0,7631	3,0066	0,2663	—	4,9099	4,8135
VIII. 6.	2,5300	0,6642	1,2517	0,0982	0,0028	0,7318	0,7186	2,8595	0,1010	—	4,5469	4,4109
VIII. 13.	2,6300	0,7061	1,3157	0,0910	0,0035	0,7822	0,7119	2,9095	0,3100	—	4,7463	4,7136
VIII. 19.	2,0775	0,6297	1,4743	0,1575	0,0021	0,7642	0,7119	2,6545	0,1647	—	4,3411	4,2953
VIII. 27.	2,5950	0,5312	1,2426	0,0824	0,0017	0,6758	0,7119	3,0456	0,0737	—	4,4529	4,5070
IX. 3.	2,8495	0,4852	1,4213	0,1120	0,0032	0,6929	0,7161	3,3094	—	0,0009	4,8712	4,7193
IX. 10.	2,9350	0,4548	1,5469	0,1338	0,0021	0,6817	0,7182	3,2371	0,0637	0,0017	5,0726	4,7024
IX. 17.	2,5450	0,4984	1,4574	0,1005	0,0021	0,6282	0,7036	3,0495	0,0283	0,0052	4,6034	4,4148
IX. 24.	2,4800	0,9934	1,1609	0,1242	0,0025	0,6563	0,6828	3,0595	0,0363	0,0023	4,7610	4,4372
X. 1.	2,2860	0,3465	1,2017	0,1120	0,0036	0,6028	0,5579	2,6896	—	0,0060	3,9498	3,8563
X. 8.	1,6635	0,5443	0,5617	0,0680	0,0125	0,2930	0,4829	1,9397	—	0,0017	2,8500	2,7173
X. 15.	1,6710	0,4401	1,1056	0,0772	0,0018	0,5436	0,4413	2,1097	—	0,0009	3,2957	3,0955
X. 22.	1,8635	0,5837	0,7834	0,0839	0,0029	0,6197	0,5453	2,1796	—	0,0018	3,3174	3,3464
X. 29.	1,4650	0,4540	0,4378	0,0724	0,0064	0,4056	0,4266	1,6497	—	0,0052	2,4356	2,4871
XI. 4.	1,3835	0,4294	0,4995	0,0281	0,0104	0,3831	0,3601	1,6397	—	0,0011	2,3509	2,3840
XI. 12.	1,5100	0,4737	0,5626	0,0899	0,0032	0,4296	0,4309	1,8297	—	0,0010	2,6394	2,6912
XI. 19.	1,2290	0,4189	0,5509	0,0417	0,0093	0,4197	0,3539	1,4398	—	0,0010	2,2498	2,2144
XI. 28.	1,6830	0,3391	0,4087	0,0509	0,0050	0,3070	0,4688	1,7397	—	0,0017	2,4867	2,5172
XII. 3.	1,6755	0,3047	0,4686	0,0425	0,0029	0,3437	0,4380	1,7897	—	0,0014	2,4942	2,5728
XII. 9.	1,5120	0,2693	0,4326	0,0670	0,0118	0,3068	0,3872	1,6597	—	0,0014	2,2927	2,3551
XII. 18.	1,8520	0,5988	0,6304	0,0650	0,0011	0,4423	0,6261	2,0697	—	0,0012	3,1473	3,1393
XII. 22.	1,4405	0,5141	0,4178	0,0396	0,0125	0,2282	0,4825	1,6897	—	0,0010	2,4245	2,4014
XII. 30.	1,3480	0,6389	0,3730	0,0645	0,0118	0,2056	0,5235	1,6597	—	0,0007	2,4362	2,3895

Table 6.

Maros	Ca	Mg	Na	K	Fe	Cl	SO_4	HCO_3	CO_3	PO_4	Cations	Anions
II. 2.	1,9990	0,6424	1,6860	0,0707	0,0052	1,9916	0,2395	2,2041	—	0,0025	4,4033	4,4379
II. 29.	2,0404	1,0722	1,2086	0,0999	0,0093	1,3940	0,7460	2,2747	—	0,0206	4,4304	4,4353
III. 7.	2,7997	0,7986	1,6000	0,1162	—	1,8760	0,9582	2,3140	—	0,0074	5,3145	5,1556
III. 14.	2,9215	1,0082	1,7750	0,0482	—	1,8730	1,2524	2,6025	—	—	5,7529	5,7279
III. 21.	2,4510	0,9630	1,7200	0,1125	—	1,9183	0,9512	2,3635	—	—	5,2465	5,2330
III. 28.	1,3825	0,6189	—	—	0,0015	1,2060	0,7330	2,1235	—	—	—	—
IV. 24.	1,6475	0,5042	0,4480	0,0772	—	0,3761	0,5097	1,6426	—	—	2,6769	2,5284
V. 16.	1,3860	0,8261	0,6990	0,0953	0,0093	0,7915	0,4865	1,6430	—	—	3,0157	2,9210
V. 23.	1,7750	0,7528	0,6380	0,0938	0,0038	0,8817	0,6706	1,7007	—	—	3,2634	3,2530
V. 30.	1,8760	0,6294	0,6430	0,1039	0,0134	0,9183	0,5920	1,7587	—	0,0033	3,2657	3,2723
VI. 6.	1,6470	0,7216	0,6460	0,0823	0,0032	1,0310	0,5543	1,6197	—	—	3,1001	3,2050
VI. 13.	1,5650	0,8784	0,8209	0,0939	0,0035	0,6339	0,6162	1,9797	0,1690	—	3,3617	3,3958
VI. 20.	1,8200	0,6190	1,3308	0,1207	0,0021	1,3056	0,5212	1,9696	0,1100	—	3,8926	3,9064
VI. 27.	1,8125	0,6075	0,9522	0,0729	0,0025	1,3591	0,3422	1,7497	—	—	3,4476	3,4510
VII. 4.	2,0495	0,7988	1,2870	0,0923	0,0011	1,4451	0,6126	2,1396	—	—	4,2287	4,1973
VII. 11.	1,5510	1,5649	0,7165	0,1156	0,0021	0,6592	0,6091	2.5995	0,1200	—	3,9501	3,9878
VII. 18.	2,3820	0,8834	1,5400	0,1366	0,0029	2,2394	0,5989	2,0297	0,0400	—	4,9449	4,9080
VII. 25.	2,4675	0,8333	1,6496	0,1041	0,0140	2,2090	0,6330	1,6317	0,4900	—	5,0685	4,9547
VIII. 1.	2,3950	0,7685	1,2291	0,1194	0,0032	1,4873	0,5304	2,6235	0,0463	—	4,5152	4,6875
VIII. 8.	2,3925	0,6741	1,4169	0,1084	0,0025	1,5682	0,5989	2,3375	—	—	4,5944	4,5046
VIII. 15.	2,4150	0,5082	1,6743	0,0974	—	1,6592	0,5579	2,5096	—	—	4,6949	4,7267
VIII. 22.	2,4505	0,4540	1,6017	0,1025	0,0011	1,4873	0,5100	2,4895	—	0,0009	4,6098	4,4878
VIII. 29.	2,9150	0,4491	1,8056	0,1258	0,0011	1,6563	0,6844	2,6496	0,2647	—	5,2966	5,2550
IX. 5.	3,0750	0,3809	1,6404	0,1667	0,0028	1,5239	0,4996	2,9700	—	—	5,2658	4,9935
IX. 12.	2,9950	0,3425	—	—	0,0032	1,4003	0,5579	2,7595	—	0,0160	—	—
IX. 19.	2,5325	0,7159	1,4165	0,0578	0,0021	1,3803	0,5287	2,4796	0,0637	0,0060	4,7248	4,4583
IX. 26.	2,8310	0,6231	1,6282	0,1233	0,0025	1,5408	0,5079	2,8495	—	0,0010	5,2081	4,8992
X. 3.	2,6190	0,4975	2,0778	0,1143	0,0136	1,8113	0,5329	2,7000	—	0,0010	5,3222	5,0452
X. 10.	2,2800	0,4721	1,6456	0,1701	0,0032	1,5465	0,5079	2,2000	0,0920	0,0010	4,5710	4,3474
X. 17.	2,4550	0,4803	2,1478	0,0882	0,0011	1,8225	1,1407	2,1000	—	0,0010	5,1724	5,0642
X. 24.	1,8545	0,4942	1,1509	0,0744	0,0068	1,1366	0,5828	1,9297	—	0,0060	3,5808	3,6551
X. 31.	1,8655	0,4794	1,0222	0,0997	0,0029	1,1296	0,3955	1,9697	—	0,0017	3,4697	3,4965
XI. 5.	1,6265	0,4442	1,1496	0,0680	0,0029	1,0450	0,4267	1,8397	—	0,0018	3,2912	3,3132
XI. 14.	1,9095	0,5090	1,2293	0,0404	0,0035	1,2200	0,4496	1,9397	—	0,0017	3,6920	3,6610
XI. 21.	2,1240	0,5542	1,1870	0,0670	0,0021	1,4131	0,5371	1,9797	—	0,0017	3,9343	3,9316
XI. 29.	1,7595	0,6741	1,0983	0,0650	0,0029	1,3094	0,4380	1,8597	—	0,0016	3,5998	3,6087
XII. 5.	1,7885	0,3346	0,5809	0,0542	0,0125	0,5827	0,3697	1,8197	—	0,0010	2,7707	2,7731
XII. 10.	1,6225	0,6481	0,6313	0,0627	0,0047	0,7069	0,4140	1,7597	—	0,0015	2,9693	2,8752
XII. 19.	1,6885	0,7934	0,7183	0,0696	0,0021	0,8127	0,5612	1,8497	—	0,0009	3,2719	3,2245
XII. 23.	1,7065	0,5847	0,4174	0,0402	0,0036	0,7099	0,5202	1,7097	—	0,0013	2,7524	2,9411
XII. 31.	1,7440	0,3596	0,4617	0,0629	0,0029	0,4451	0,4963	1,7597	—	0,0009	2,6311	2,7020

vízállás m-ben
water level m.

A Tisza vízállása Szegednél
water level of the Tisza at Szeged
Maros vízállása Makónál
water level of the Maros at Makó
lebegtetett hordalék a Tiszában Szegednél
floating material in the Tisza at Szeged
lebegtetett hordalék a Tiszában Tápénál
floating material in the Tisza at Tápé
lebegtetett hordalék a Marosban Makónál
floating material in the Maros at Makó

g/m

1952 I. II. III. IV V. VI. VII. VIII. IX. X XI XII. 1953 I.

Tisza Tápé

Maros Deszk

Tisza Szeged

> 0·016 mm Ø
0·016 - 0·002 mm Ø
< 0·002 mm Ø

Fig. 8.